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# Psychological Bulletin

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THE  
PSYCHOLOGICAL BULLETIN

LEGIBILITY AND EYE MOVEMENT IN READING

By MILES A. TINKER

*University of Minnesota*

The study of legibility of print and eye movements in relation to reading began with the work of Javal (44, 45, 46) and his associates (52, 53) in France about 1880. These early studies were soon followed by the investigations of Cattell (15), Erdmann and Dodge (25), Sanford (68), Huey (40, 41), and others.<sup>1</sup> Huey (40), Dodge (23, 24), and Judd (47) have made especially important contributions to the technique of recording eye movements.<sup>2</sup>

*Legibility*

In comparing the relative legibility of three type faces Burtt and Basch (10) used all upper and lower case letters of the alphabet, except j k l q u x y and z. They found that Cheltenham was more legible than Baskerville Roman and the Baskerville in turn was more legible than Bodoni. Greater differences were found for the upper case than for the lower case letters. For either upper or lower case the differences in legibility varied with the letters and greatest differences occurred with letters involving light strokes. Pyke (63), in a comparison of the legibility of eight different type faces, found rather wide differences in one experiment and small differences in others. Lack of agreement among individual observers was marked.

<sup>1</sup> See references 17, 18, 20, 21, 22, 28, 37, 51, 64, 67. This paper will be devoted to literature appearing since 1914. Studies or parts of studies on legibility of print, or on some phase of eye movement in reading will be reviewed.

<sup>2</sup> For a description of photographic methods of studying reading, see Gilliland (31). Also see references 1, 19, 30, 69.

Although Pyke used the cancelation test in one experiment as a measure of legibility he does not attempt to show that speed of cancelation itself is a valid test for legibility of type. He found that the most legible type face was also best liked. Although his laboratory experiments showed Old Style to be the most legible type face and Modern Condensed the least legible, Pyke doubts whether the differences in legibility found in laboratory experiments hold in ordinary reading situations. In his opinion extremely large typographical differences must be present before one can conclude that there are real differences in the objective legibility of types.

Approaching the problem from the viewpoint of physics, Legros and Grant (54) employed "specific legibility" as a criterion of type legibility. "Specific legibility" is the product of the mean legibility coefficient (the ratio of the sum of the areas peculiar to the individual characters to the sum of the total areas of the two characters) by the mean blackness. Their computations showed that Old Style Roman type was more legible than Modern Face Roman and that the latter in turn was more legible than Sanserif. Blackfriars was termed very legible and German type (Fraktur) extremely illegible. Although the good legibility of Old Style type as determined in this study corresponds to Pyke's findings, the results should be more extensively checked by other experimental approaches.

In an analysis of eye movement records Gilliland (32) found from one to two more fixations per line in reading handwriting and Old English type than ordinary modern type. The first reading of handwriting was found to be 17 per cent. and that of Old English type 35 per cent. slower than re-reading the same material printed in ordinary Caslon type. The material in handwriting and Old English type tended to disturb the regular oculomotor habits of silent reading. This was shown by an excessive number of regressions and a tendency to fixate words or even syllables rather than larger reading units.

In comparing legibility of Roman with German type Radojevic (65) showed that for upper case letters there was a fair advantage for Roman but for lower case letters there was a small advantage for the German type. Employing three types of procedure (peripheral-vision, distance, and short-exposure), Wick (81) found a small advantage of German over Roman type for lower case letters and words. The conclusion reached was that German type has superior legibility. In a similar investigation Kirsch (50) found the Roman type more legible for upper case letters than German

type, but less legible for lower case letters and words. These results for the lower case letters are contrary to many previous reports which have usually indicated that Roman type is decidedly more legible than German. More controlled experiments are needed to secure unequivocal data for these comparisons. It is especially desirable that the subjects in such experiments be about equally familiar with both the German and the Roman types in order that the factor of familiarity may be adequately controlled.

Certain recent studies have concerned themselves with the legibility of characters in visual test types. Ewing's report (26) gives the visual values of certain Gothic and Block letters as determined by comparison with the Landolt broken ring. The results show that few of the letters have equal legibility. Block letters were found superior to Gothic letters for visual test types. Working with Green's type, Hartridge and Owen (38) found that letters approximating the isolated contour type of test object such as L and J were relatively very legible whereas others approximating the grating type of test object, as R and B, were of very low legibility. Between these extremes was a group of letters of about equal legibility and medium difficulty. The author recommends that the latter ones be employed for visual test cards. Using test types, Banister, Hartridge, and Lythgoe (3) determined the relative legibility of the letters of the alphabet<sup>8</sup> by the short exposure and the distance methods. As the results from the two methods correlated highly they recommended the first method since it is applicable to a large number of subjects tested simultaneously. Such a method might find considerable usage for testing school children. They also found a direct relationship between degrees of illumination and legibility of letters. In a later study Banister (4) determined the orders of legibility of block capital letters (Green's type) for two different groups of subjects. He found that those letters belonging to the same class, *i.e.*, were similar in form, were confused most often with each other when the retinal image was no longer distinct. He concludes, therefore, that such letters rather than those of equal legibility should be employed for visual tests.

Judd (48) made an analytical study of the eye movement records of adults obtained during the reading of materials printed in different

<sup>8</sup> For the orders of legibility determined in this group of studies and their correspondence to other findings, see the reviewer's forthcoming paper, "The Comparative Legibility of the Letters, the Digits, and Certain Mathematical Signs," in the *Journal of General Psychology*, No. 2.

sized types. He found that the unit of recognition remained about the same when he used eleven point type as when the size of type was doubled or reduced one-half. Later, in a more elaborate study, Gilliland (33) recorded eye movements of subjects reading two kinds of materials. One group of materials was set up in type ranging from 6 to 54 points and the other in type of 3 to 90 points. The length of line ranged from  $1\frac{1}{2}$  to 15 inches. Each paragraph was paired with a paragraph of identical content and printed with 12 point type in lines  $3\frac{1}{3}$  inches long. The results showed that the reading of the average adult was not greatly affected by changes in the size of type between the limits of 6 and 36 points. However, the rate of reading became somewhat slower with type larger than 18 point. Although these two studies indicate small variation in eye movement habits when the size of type is varied within rather wide limits they do not show what influence such changes have on fatigue in reading. The latter should be investigated.

Tinker (77) obtained reading reaction-times for the letters n, m, t, x, y, and the digits 1 to 5 when they were used in the body, and as exponents and subscripts of mathematical formulae. As exponents or subscripts the characters were found to be less legible than in the body of the formula. When used as exponents or subscripts all the letters and the digits 2 and 3 showed significantly longer reading reaction-times. The letters lost comparatively more in legibility than did the digits when both were used as exponents and subscripts. Digits and letters in any part of formulae could be "found" quicker than they could be named, but they could be found more quickly when used in the body of formulae than as exponents or subscripts. He concluded that position as well as size is a factor in the legibility of letters and digits in formulae.

In a survey of practice in printing books for the lower grades during the last 40 years, Blackhurst (6) noted that between 1890 and 1900 there has been an increase in size of type, but since that time few significant changes have been made. The current practice conforms approximately with the recommendations of Huey (42) but are not in agreement with the experimental findings of Blackhurst (7). The latter indicated that larger type should be employed. Of the sizes of type studied he found 24 point type most readable in the first and second grades, and 18 point type most readable in the third and fourth grades. A survey by Blackhurst (6) of printing practices from 1890 to 1910 showed that there was a tendency to make the left margin regular and leave the right margin irregular

for that period. Since 1910 there has been a tendency to make both margins irregular. This is not in agreement with the conclusions of both Dearborn (18) and Huey (42) who recommend uniformity of line length because it facilitates regularity of eye movement in reading. Blackhurst (8) found that a line length of from 90 to 103 mm. gave the fastest rates and fewest errors for reading in the first four grades. These results differ considerably from the recommendations of Huey (18) and Dearborn (42). In a later study Blackhurst (9), using materials with three widths of leading (3.8, 1.8, and .5 mm.), determined the rate of reading and number of errors made by children in the first four grades. He concluded that leading 3.8 mm. wide should be the minimum employed in texts used at the beginning of the first grade; at the beginning of grade II this could be reduced to 1.33 mm.; and above the second grade to 1.0 mm. Further investigation with a greater variety of widths of leading should be made to determine the validity of these recommendations. Since 1890 the tendency in printing books for the lower elementary grades has been to steadily increase the amount of leading (6). Even yet, however, the width of leading does not conform to recommendations based upon the results of various scientific investigations.

For material printed in 12 point type and with 0 to 9 point leading, Bentley (5) found that the material with 7 point leading (about 2.5 mm.) permitted the most rapid reading. Reading rate increased steadily with greater width of leading for materials with 0 (set solid) to 3 point leading, remained about constant when the leading was increased from 3 to 6 point, and then increased considerably with 7 point leading. With more than 7 point leading the reading rate dropped so that with 9 point leading the rate approximated that for material set solid. When the material was reduced photographically to the size of 9 point and 6 point type the same relative leading was found to give the fastest reading. From this study it appears that facility and rate of reading print depend partly upon leading and that for most efficient reading conditions a definite relationship between size of type and width of leading should be maintained. Further detailed studies are needed to determine the most suitable leading for other sizes of type.

By studying the length of time required to find a name and exchange number in a telephone directory, Baird (2) found that by indenting every other line, legibility increased about 5 per cent. The insertion of  $\frac{1}{2}$  point leading increased the legibility about 13 per cent over an arrangement with the type set solid. In a recent

investigation Lyon (56) found that the leading used with 6 point type on a 7 point body gave no increase in legibility over an arrangement in which 6 point type was set solid. The author does not attempt to relate his findings to those of Baird (2) in which a contrary result was obtained. Lyon also concluded that a type larger than 7 point is not required to give good legibility in telephone directories. Furthermore a new type face in which the letters were altered in such a way as to provide as much white space as possible in the interior of the characters was designed for directory printing.

Pratt (61) determined the relative legibility of five different ways of printing a suffix after the date where a single writer has more than one title a year in a bibliography. The most legible arrangement was one in which the letter-suffix was printed above the line and separated from the date by a space. In comparing the manner of printing backbone titles on thin books and magazines, Gould, Raines, and Ruckmick (34) found that the titles could be read with approximately the same speed when they were printed from top to bottom as when printed in the reverse direction. Individual preference as well as certain positions of the book with reference to the reader gave a significant margin of choice in favor of the bottom to top direction of printing.

According to Huey (18) the use of black ink and pure white paper without gloss gives the most legibly printed page. Starch (73) cites an experiment in which the efficiency of reading print on matte white, pink, blue, and gloss white paper was determined. The results indicated that glare was the decisive factor in diminishing ocular efficiency. The matte white paper was the best and the gloss white the worst as shown by the speed of reading the material and also by the number of spontaneous winks per minute during the reading. The pink and blue papers which were intermediate in glare were also intermediate in ocular efficiency. This suggests that color of itself has little influence on legibility in reading. The Industrial Fatigue Research Board has been carrying out an investigation (27) to determine the most effective contrast between colored papers and inks. The preliminary reports of this study also suggest that color contrast is of comparatively small importance in hygienic printing.

The report (66) of the Committee on Type Faces recommends that modernized old style figures be used in mathematical tables, and that white space be employed to separate columns of figures as well as columns of ordinary printed matter. Since the report embodies opinions not founded on experimental results it is open to criticism.

Milne (59) calls attention to the lack of uniformity in the arrangement of mathematical tables. He considers old style numerical figures more legible than those of uniform height, and smaller figures with more white space easier to read than larger figures closely crowded. White space rather than lines is recommended for the separation of columns; the use of colored paper and colored ink are condemned. As no experimental evidence is cited the value of these suggestions is debatable. However, the suggested value of white space for isolating columns of printed matter is supported by the findings of Strong (74) in his work with advertisements. He found that rules and borders do not isolate as effectively as white space. Legros (55) calls attention to various legibility factors. Similarity between pairs of characters, the serif, the light-reflecting capacity, etc., were discussed and instructive illustrations given. He approaches the problem essentially from the viewpoint of the physicist and does not give adequate attention to the physiological and psychological phases of legibility.

#### *Eye Movement Studies*

In Schmidt's investigation (70) 21 grade pupils (second to seventh grade), 17 high school students, and 45 adults were subjects. The study was designed to keep reading conditions, *i.e.*, length of line, size of type, etc., constant and to use a large number of subjects for both oral and silent reading. Careful rather than maximal rate of reading was the objective. Great individual variations in number of pauses per line and in duration of pauses were found in both silent and oral reading. Fewer and shorter pauses characterized silent reading as contrasted with oral reading. The slowest silent reader read only one-third as much as the most rapid reader, and the slowest oral reader, one-half as much as the fastest. There was a higher correlation between number of fixations and speed of reading than between pause duration and speed. These correlations were higher for the high school and adult groups than for the grade pupils. Little or no difference in pause duration and number of pauses per line was found between grade children and the higher groups. This was probably due to the small number of grade pupils tested, for both Gray (35) and Buswell (13) did find such differences. Schmidt found more regressions in the reading of the elementary group than in the higher groups. In his opinion, the mechanics of silent reading are mastered by second graders. His second grade group must

have been too highly selected, however, for Buswell's study (13) indicates that mastery of the mechanics of reading usually comes in the fourth grade. Oral reading was usually slower than silent reading. Some correlation between rate and comprehension was evident for silent but not for oral reading. Schmidt found that interfixation eye movements were accompanied by divergence; fixation, by convergence. The divergence involved an upward and outward movement of the eyes and convergence a downward and inward movement. At the beginning of a fixation there tended to be a sympathetic movement of both eyes in the same lateral direction; this was opposed to the converging adjustment. Gradual shifting of the eye and isolated deviations within the reading pause were noted.

Gray (35) has also studied performance in oral and silent reading through an analysis of eye movement records. The subjects were selected by means of a preliminary survey so as to have some good, some medium, and some poor readers. He used 41 pupils of the elementary school (third to seventh grade), 10 of the high school, and 8 college students. Data from silent reading revealed two types of rapid readers: (a) those who reduced the number of pauses to a minimum; and (b) those who reduced the length of pauses to a minimum. The first type, comprising those with a wide scope of attention, was the more efficient. In general, however, the rapid readers made shorter as well as fewer pauses. On the average the upper grades had fewer pauses per line than the lower grades but only a slight decrease in pause duration. This indicates that span of attention changes more than rate of assimilation with maturation of reading habits. Regressive movements were a feature of slow readers as well as immature readers (lower grades). Oral reading showed more fixations per line than silent reading in all grades but the fifth in which they were the same. Pause duration in the oral reading was longer for about half of the subjects. Rather wide individual variations in the eye-voice span were noted, but extensive analyses of these differences were not attempted.

Buswell (13) has carried out an extensive investigation to determine the stages of growth in the span of recognition for printed material, rate of recognition for perception units, and regularity of perceptions along the line of print. These were obtained by determining the number and duration of fixation pauses and number of regressions per line in the material read. Buswell used 186 subjects consisting of students from seven elementary grades, the four high school classes, and the university. Selections were read silently and

orally. In silent reading the number of fixations decreased rapidly during the first four school years; they remained about constant from the fifth grade through the freshman year of high school; and again decreased during the middle high school period. There was a rapid decrease in pause duration up to the end of the fourth grade and a slower decrease to the end of the sixth. Thereafter there was no decrease with the exception of high school juniors. The results indicated that a pause duration of from 5 to 6 twenty-fifths of a second satisfies the perception demands of mature reading, and that this level may be reached by the end of the fourth grade. The number of regressions was reduced rapidly during the first four grades; no material change occurred through grades V, VI, and VII; but there was another reduction during the early high school period.

Buswell found that the reduction of fixation frequency was similar in oral reading to that in silent reading but on a less efficient level. Except within the third grade pause duration diminished rapidly from the first to the end of the fourth grade, but only decreased a little thereafter. The number of regressions in oral reading decreased to the silent reading level during the first six grades and then fell below that level. Growth in effective habits of eye movement showed considerable correlation with achievement on standard reading tests in both silent and oral reading. This study revealed more consistent group differences than Schmidt's (70) or Gray's (35) investigations in which fewer subjects were used. A detailed analysis of first grade reading was made by Buswell and from this suggestions for the teaching of reading were formulated. Furthermore he studied carefully the eye movement records of individuals whose reading deviated markedly from the group trends, and suggested remedial measures.

As part of a larger investigation on silent reading O'Brien (60) obtained photographic records of eye movements before and after his subjects were given drill in rapid silent reading, and special training to decrease vocalization. Analyses of the eye movement records were made to determine the variation of physiological factors accompanying the increase in reading rate. He found that the greater speed in silent reading acquired through the special drill was accompanied by a noticeable reduction in the number of fixation pauses and the number of regressive movements. This indicated a widening of the perceptual span and a greater regularity of eye movements. It was consistent for slow, medium, and fast readers. Following

this special training there were indications of a slight tendency to increase the pause duration.

In studying the various types of silent reading Judd and Buswell (49) found significant variation of reading performance in adjustments to changes in the content of passages. With the more difficult and unfamiliar material there was an increase in the number of fixations per line, the duration of fixation pauses, and the number of regressive movements. The subjects read fiction, geography, rhetoric, easy verse, French grammar, blank verse, and algebra. Fiction was the easiest for all subjects but the other subject matter varied in difficulty for the different readers. All materials except fiction were found to be difficult reading.

Changes in reading habits were brought about by setting up certain reading attitudes which effected changes in the readers' attention. This was done either by giving explicit directions or unexpectedly asking questions on the first passage read. This latter method would bring about a changed reading attitude for the second passage read. Variations in reading also occurred in various kinds of analytical study such as reading to paraphrase or for a verbatim report.

Eye movements in reading French and Latin were compared with each other and these, in turn, compared with the reading of English. Good third year language students were subjects. Symptoms of a labored type of reading in the French were indicated by the large number of fixations per line. However, none of the records demonstrated that any student read Latin. There was an aimless looking at words with numerous irregular eye movements which indicated an unsuccessful attempt at analysis. These eye movements in reading Latin took on the character of mere helpless wandering. No attempt was made to correlate complexity of eye movement with amount of meaning present in reading French and Latin. Such a study might naturally follow this preliminary work.

The eye-voice span in reading has been studied by Buswell (11, 12) by a photographic technique with a dictaphone attachment. It was found that the eye-voice span was generally fully developed by the fifth grade. Poor readers, however, continued to improve slowly through high school. Fast readers had a wider span than slow ones in every grade. In an earlier study Quantz (64) had noted that in oral reading the rapid readers read farthest ahead of the voice. Buswell found that reading rate and eye-voice span increased together. Little correlation was noted between eye-voice

span and position in the line of the words being spoken; however, the span was somewhat shorter at the right end than at other positions in the line. Quantz (64) had found a more definite relation between eye-voice span and position in the line. His averages showed that when the reader was pronouncing a word at the beginning of a line the eye was 7.4 words in advance of the voice; in the middle it was 5.1 words, and at the end, 3.8 words. It is reasonable to consider Buswell's results more reliable than those of Quantz for he employed more readers and used a more accurate technique. Buswell found, however, that width of eye-voice span varied considerably with position in the sentence. It was greatest at the beginning of the sentence, less within, and least at the end. These differences were most prominent for good readers. Certain records showed that at times the eye-voice span was very narrow. Quantz (64) had noted that difficult words reduced it to zero. Buswell's results showed a negative correlation between width of eye-voice span and number of fixations per line. There was no consistent relation between eye-voice span and number of regressive movements, although subjects having the largest number of regressions had a somewhat narrower span. Little or no relation was found between eye-voice span and length of fixation pauses. Records from reading a paragraph containing "test words" showed that difficulties in the recognition of meaning were reflected in the character of the eye movements. With such material subjects with a wide eye-voice span found less difficulty than subjects with a narrower span. Development of the attention span in reading was found to correspond closely to the growth of the eye-voice span.

Terry (75, 76) analyzed the eye movements made in reading numerals in arithmetical problems and isolated numerals in lines. The subjects read 2.38 digits per fixation on numerals in the problems and 6.47 letters per fixation on words. This indicated a comparatively short attention span for numbers where the reading tends to be quite analytical. This agrees with Dearborn's (18) conclusions. Also fixation pauses on numerals were found to be about 35 per cent longer than those on words. A decidedly larger percentage of regressive pauses occurred with numerals than with the words of the context. Numerals of few digits were usually completely read during the first reading but the longer numerals were only partially read by some subjects at the initial reading. In partial first readings the outstanding facts concerning the numerals were noted but the

details were not apprehended. Whether numerals were re-read or not depended on the habits of the individual. Re-reading was for the purpose of verification of details or copying numerals for computation.

Terry distinguishes two types of fixation pauses made by subjects reading groups of digits: (a) reading-pauses, employed to recognize digits and relationships, and (b) guiding-pauses probably used to locate the initial and final digits of the numerals read. Total reading time and number of pauses per numeral were found to vary directly with the length of the numeral. Some individuals read numerals with a relatively large number of rather short pauses; others used few but longer pauses. The former method gave the quicker reading time. One or two, or two or three digits were read per fixation according to the reading habits of the subject. Since Terry's subjects read arithmetical problems and isolated numerals less rapidly than ordinary prose he concluded that both were decidedly more difficult types of reading than ordinary prose. However, the reviewer believes that one should be careful about drawing such conclusions for the reading of isolated numerals since they are symbols and involve a larger amount of abbreviation than words. Numbers are a compact way of printing. Their very compactness probably requires a longer reading time than do words per unit space.

Buswell (14) found that the eye movements employed in the addition of digits in columns of varying length and difficulty were much shorter than in ordinary reading. Addition by adults was characterized by: (1) regular progress of fixations either up or down the columns; (2) relatively short pauses; (3) pauses of fairly uniform duration; (4) about one fixation per digit; (5) absence of periods of confused procedure; (6) a tendency at times to group two digits in a single fixation; and (7) location of first fixation somewhat down the column. For children, on the other hand, eye movements in addition were characterized by: (1) regressions at the beginning as well as within the columns; (2) wide variations in duration of pauses; (3) a tendency on the part of children with mature adding habits to grasp two digits in a single fixation; (4) irregular eye movements up and down the columns (this often became random and complex, and was related to poor arithmetical ability); and (5) longer or more numerous fixations for difficult spots. In adding, pause duration was found to be much longer than in ordinary reading. A few fixations were more than four seconds long. It was concluded that eye movements are adapted to mental processes and that com-

plex eye movements and very long fixations denote confused central processes.

According to Jacobsen (43) pause duration and number of fixations of mature and immature subjects reading music are somewhat similar to those in ordinary reading. Complexities in the music tended to increase both the length of pauses and the number of fixations. In two clef music there was a general tendency to read chords from above downward. The mature readers of music had fewer and shorter pauses and fewer movements from clef to clef than the immature readers.

Pressey (62) tested silent reading proficiency in two groups of children. The groups were so selected that the intelligence of the two groups was approximately equal, but their inequality of reading ability amounted to a two grades' difference. Good readers were found to have fewer fixations and regressive movements per line and demonstrated greater accuracy in the return sweep from the end of one line to the beginning of the next. The good readers also showed less lip movement in silent reading; better comprehension, and better pronunciation in oral reading. Employing a technique described in his earlier paper (79) Wager (80) found that six individuals differed greatly with respect to average times for fixation-accommodation. Those subjects with short times for fixation-accommodation were fast readers; slow readers usually took longer times for fixation-accommodation. Wager concluded that native differences in muscular reaction times, as shown in fixation-accommodation adjustments, are determining factors in reading rates. Such a conclusion can only be tentative because of the small number (6) of subjects used.

Miles and Shen (57), comparing eye movements for reading Chinese in the vertical and horizontal axes, found that length of pause duration was not consistently longer or shorter in either arrangement although on the average the vertical had a slightly longer duration. However, for number of words read per fixation and number of words read per second the vertical arrangement had a small advantage. The reading of Chinese in the horizontal axis involved eye movements of smaller angles, many more and shorter pauses for the Chinese students than the reading of English. Also they found that the number of words read per fixation and per second was greater for the Chinese language. The compact arrangement of Chinese words probably accounts for this.

In the reading of Chinese in the horizontal axis fixations were

steadier and more distinct than for Chinese in the vertical axis; in the latter, the fixations showed a tendency to glide into a continuous curve. The return sweep of the eye to the beginning of a new line of vertical print sometimes took the form of a sharp loop just preceding the first fixation in the line. Further discussion of this study appears in articles by Miles (58) and Shen (71).

In a more elaborate investigation Shen (72) studied eye movements in reading Chinese in both the vertical and horizontal arrangements where size of type and line length were held constant. On the average, 15.0 fixations per line ( $6\frac{1}{2}$  inches long) for vertical and 18.3 per line for horizontal were used. Greater variation in number of fixations was shown in the horizontal arrangement. The differences between vertical and horizontal were statistically reliable. The first line of reading required more fixations than other lines, and the first word in a line was usually fixated while the last fixation in the line more often than not fell short of the last word. This is comparable to performance in reading English. The average interfixation distance was found to be  $1^\circ 15'$ . According to Shen's computations the interfixation movements took place within 10 to 15  $\sigma$  which means that the perception time per line (the time taken by fixation pauses) consumed from 19/20 to 29/30 of the reading time. Erdmann and Dodge's calculations (25) for this gave 12/13 to 23/24. Shen's figures are probably more accurate because of the technique employed. There was little difference in variation or mean pause duration for the two printing arrangements. Pause duration was about .3 second for both). About twice as many regressions per line in the horizontal as in the vertical reading were found. Here as in the preliminary work of Miles and Shen (57) it was found that the distinction between saccadic movements and movements of a gliding nature were less clear-cut in vertical reading. All indications suggest that "the more complicated mechanism for vertical movement is particularly adaptable for shifts of small angles and of a somewhat gliding nature." The study clearly indicated that factors other than habit are influential in the more efficient reading of Chinese in the vertical arrangement.

In their study of reading efficiency \* in the vertical and horizontal axes by Chinese students Chen and Carr (16) concluded that habit accounted for the fact that the majority of the readers did better with the vertical arrangement of Chinese characters on the one hand

\* Not an eye movement study.

and the horizontal arrangement of the English materials on the other. Tu's (78) Chinese subjects read 4.7 words per second in the vertical and 3.61 in the horizontal. After a practice period the speed of reading was 5.54 words per second in the vertical and 5.01 in the horizontal; a greater gain appeared in the vertical. Employing the mirror method of direct observation it was found that in vertical reading, 3.70 words per fixation were read and in the horizontal 3.55. He concluded that habit was responsible for the differences in favor of the vertical arrangement. However, any comparison of efficiency in reading Chinese in the two arrangements must consider Shen's (72) findings which emphasize the physiological factors involved.

Eye movement records have been employed for studying individual cases with reading difficulties. Freeman (29) found in studying a case of alexia that the subject's eye movements were so irregular and uncoördinated that it was impossible to tell on some records which positions corresponded to the beginning and which positions to the end of the lines. This indicated lack of an orderly progress of the attention along sentences and parts of sentences. After the subject's case was diagnosed and he was given a period of training his eye movements showed fairly well organized habits. This was correlated with considerable progress in reading ability. Rather extensive use of eye movement records has been made by Gray (36) as an aid in the diagnosis of cases requiring remedial training in reading. Records showed such things as: (1) an unusual number of fixations, indicating a narrow span of attention; (2) periods of confusion, indicating inadequate mastery of word recognition; (3) numerous regressions, demonstrating a lack of rhythmical eye movement habits and difficulties in recognition or interpretation; (4) extra long fixation pauses, denoting a slow rate of recognition; and (5) regressions in practically every line, following the first fixation, showing inaccuracies of the return sweeps from the end of one line to the beginning of the next. Hincks (39) has also employed eye movement records to facilitate the diagnosis of reading disability and to measure improvements after special training. All her subjects showed irregular and uncertain eye movements and fixations before special training was given, but under training the movements became more regular. These studies show the value of eye movement records in the investigation of disabilities in reading.

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## SPECIAL REVIEWS

C. JUDSON HERRICK. *Brains of Rats and Men: A Survey of the Origin and Biological Significance of the Cerebral Cortex.* Chicago: University of Chicago Press, 1926. Pp. xiii+382.

Man and the rat are far separated on the mammalian scale, and yet both of these types of organisms have been intensively studied under laboratory conditions. This fact has been used with dramatic success in the present book by Professor Herrick in presenting a semi-popular story of the development and function of the nervous system and particularly of the cerebral cortex.

"What we do with our brains" is the title of the first chapter of the volume. Under this heading the author prepares his reader for the essential complexities of the following pages by pointing out (p. 9) that according to a conservative estimate: "During a few minutes of intense cortical activity the number of interneuronic connections actually made (counting also those that are activated more than once in different associational patterns) may well be as great as the total number of atoms in the solar system." The development of this intricate cortical apparatus is traced in comparative terms. Fundamentally, the author holds that the function of the cortex is the integration and the correlation of adaptive behavior sequences. This view leads him to a consideration of the conditioned response. Growing out of this discussion, the possibility of a rapprochement between the stimulus-response physiology and the *Gestalt* theory is suggested.

The human cortex is next considered in relation to the conditions found in the fish, reptile, and lower mammal. It is further demonstrated that the cortex can in no case be considered in isolation and therefore the relationship between this apparatus and the corpus striatum and the thalamus is presented in each type that is treated. On the basis of this exposition the modern notion of cortical projection centers is made clear. It is shown, moreover, that the interaction of physiologically differentiated cortical fields is probably an essential feature of all cortical activity.

On the basis of this comparative study of the functions of the central nervous system, the question is asked: "How do rats learn?" In the answer to this question much attention is given to the exposition and criticism of the experiments and conclusions of Professor K. S. Lashley. Evidence is given to show, as an example of one

of the many problems treated in this section of the book, that associative memories may be acquired in the absence of the cerebral cortex. This observation is directly opposed to the contention of Professor McDougall ("Outline of Psychology," 1923, p. 55) that the mechanistic view of learning is weakened by the fact that "all we know of the function of the nervous system" tends to make it very improbable that an animal deprived of a cerebral cortex can learn. The evidence, however, is held to be unimpeachable that the cortex is essential in learning of the higher types, particularly in learning which involves an advanced degree of "insight."

No evidence is discovered for the once commonly taught view that cortical activity, when thoroughly automatized, is pushed back to subcortical levels. It is pointed out that one of the most significant general criticisms of all work upon the correlation of the learning process and cortical structure is that the conditions of "drive" may be different in any two cases compared. Professor Washburn ("The Animal Mind," 3d Edition, 1926, pp. 329-337) has recently pointed out with telling effect the importance of "drive" in an understanding of the learning process. One may believe, as does the reviewer, that the stimulus, in the last analysis, is the "drive"; but this in no measure makes it possible for one who would understand the educative process to neglect the significance of the dynamogenic effect of the cortex upon subcortical activity and learning. Finally, Lashley's conception of equipotentiality of the cortex is subjected to criticism. Certain fundamental objections are urged against this conception. In a series of cleverly designed diagrams, Herrick attempts to suggest the anatomical basis of some of Lashley's findings in regard to the relationship between the brains and the light-reaction habits of rats (p. 200).

The functions of the frontal lobes and of the association centers are considered. In the latter study a physiological basis of the mnemonic vestige is suggested. The view presented is illuminating, particularly in view of the bizarre speculation that has so often characterized this field. Something of Herrick's dynamic view of the engram may be suggested in the following excerpt (p. 247): "The function of speaking my friend's name when I see his face is certainly not localized among thousands of similar 'memories' in any simple mosaic pattern that can be mapped on the cortical surface. It is localized, no doubt, in a very different way, for it involves the reactivation of systems of neurons articulated in definite anatomical patterns which may ramify from pole to pole of the cerebral hemi-

sphere. The systems of neurons colligated with the other memories ramify equally widely, and many of the neurons involved in one memory may also be involved in a dozen other memories, but linked in different patterns."

In the last chapters Herrick develops his view of the subconscious and of the relationship between consciousness and the brain. The vital function view of consciousness is always suggestive and the present account is an advance over previous formulations of this position. In many ways, however, this position in regard to consciousness, even as here developed, is open to the charges already urged by Professor Titchener ("Functional Psychology and the Psychology of Act: I," *American Journal of Psychology*, 32, 1921, pp. 519-542) against earlier functional systems of the biological sort. On the basis of the view of consciousness presented, certain suggestions are made in regard to the intellectual and moral natures of rats and men.

In general evaluation it may be said that, in spite of its popular aim, the present volume is significant for the student of physiological psychology. The book should be valued by psychologists because it is written by one who has a real knowledge of the science of mental life: an accomplishment all too uncommon in neurologists and physiologists. From the reviewer's personal standpoint in physiological psychology, the shortcoming of the present volume is that too little effort is made to show the relationship between the functions of the special organs of the central nervous system and the properties of the nerve muscle preparation and the elementary reflex. The key for the solution of certain problems of the central nervous system suggested in the introduction to Adrian and Lucas' classic monograph upon "The Conduction of the Nervous Impulse" might well have been used in certain questions debated in the present volume. Possibly such a program is still too ambitious. It would be most valuable, however, if Professor Herrick at some later time might amplify the consideration of the matters treated in the present volume by an inclusion of information concerning such phenomena as those considered in Sherrington's "The Integrative Action of the Nervous System" and J. F. Fulton's new and illuminating work upon "Muscular Contraction and the Reflex Control of Movement." In such an hypothetical volume the reader might be able to learn, even more adequately than is the case in the present able work, why "men are bigger and better than rats."

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PIÉRON, H. *Thought and the Brain.* (Translated from the French by C. K. Ogden.) N. Y.: Harcourt, Brace, 1927. Pp. 262+xvi.

The present volume is one of the series known as the "International Library of Psychology, Philosophy, and Scientific Method." The original work by the Professor of Psychology at the Collège de France appeared under the title of "Le Cerveau et la Pensée" (Alcan, Paris, 1923). The translation was made by Mr. C. K. Ogden, the editor of the series in which the English edition appears.

The book is divided into four general sections which deal with the following topics: (I) the general conception of neuro-mental functioning, (II) the receptive and incito-motor function, (III) the verbal functions and thought, and (IV) the affective regulation of mental life.

In the first of these sections listed above, a dynamic view of the nature of the human nervous system is presented. This consideration is followed by a treatment of the relationship between mental functioning and the brain. On the basis of this exposition, an elaborate summary is presented of the experimental work and the current speculation upon the question of brain localization. American readers will be interested in the fact that the work of Doctors Franz and Lashley is criticized in this section.

The second section of the book is largely devoted to a consideration of the activities which are supposed to occur in determining the simpler mental processes. A relationship is traced between the central nervous system and certain other functions, as for example, diffused sensation, cutaneous sensation, deep sensibility, proprioceptive stimulation, and the activity of the higher senses. Some reference is also given to the supposed significance for psychology of the conception of chronaxy developed by Lapicque. Müller's principle of the specific energy of nerves is also considered.

The third section of the book is devoted to a treatment of the cerebral mechanism. Aphasia and the so-called language centers are considered in detail. In introducing this presentation, a short history is given of the work upon localization. The contributions of such men as Hughlings Jackson, Broca, Bastian, Wernicke, Charcot, Dejerine, and Pierre Marie are considered. Word blindness and word deafness are discussed in detail. The conclusion is reached, at times it almost seems to the reviewer in spite of the evidence, that the correspondence between function and localized area in the cortex was never more firmly established than it is to-day.

In the fourth and last section of the work the affective life is dealt with. Here the view is presented that what is termed "interest" is really dependent upon the liberation of a not too clearly defined entity termed, in this book, "nervous energy." The last chapter in this section is devoted to the data of affective pathology in which an energetic view of the effective life is developed in some detail.

The work as a whole is difficult to evaluate. It is certainly the work of a scholar who has an extensive knowledge of the literature of psychophysiology and of those parts of biology which are important for an understanding of mental life. The philosophic position of the writer dictates certain conclusions which are at variance with the conclusions reached upon the same evidence by other writers. If a comparison were made between the present volume and Professor Herrick's work upon a similar topic—"The Brains of Rats and Men"—it appears to the reviewer, at least, that the American book will be found of greater value to current psychology. It must be pointed out, however, that the two works are in no sense strictly comparable. In any case the many references given in the current work will be of value as an introduction to modern work upon the relationship of the nervous system and mental life.

The translation seems adequate. The illustrations of the present English edition, while still leaving much to be desired, are nevertheless a great improvement over the drawings appearing in the original edition. In the French edition the cuts were most inadequate. To cite but a single example, taken from page 5, the arrows indicating the functional course of a reflex arc show the impulse passing from the central apparatus to the sense organ, and not from the sense organ to the cord, as should be the case.

In conclusion, however, it must be stated that the present volume is a distinct contribution to the English literature on physiological psychology.

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OGDEN, C. K. *The Meaning of Psychology*. New York: Harper, 1926.

Professor Ogden's book is written for those "who are seriously approaching psychology for the first time" . . . and who "will welcome a brief account of the nucleus of accredited opinion from which the growing science is tending to develop" presented in the "simplest possible language" (p. xx). Such an aim makes it diffi-

cult to review the contents of the book. It is, of course, "readable," but since the author seems also to expect his colleagues to take it as a serious presentation of his own point of view, the present reviewer will restrict his remarks to the scientific aspects of the book.

Dr. Ogden approaches his subject in the traditional manner. "The mind is a starting point. Psychology ultimately provides a basis for all other studies—Ethics, Economics, Aesthetics, Ethnology, Grammar, Politics, and Mathematics. Even Physics is ultimately driven back on hypotheses which are essentially matters of psychological criticism and construction" (p. 3). Introspection is the main instrument of psychology and a certain amount of training is necessary in introspection as in most other pursuits (p. 5). "Consciousness is supposed to be associated with the higher parts of the nervous system, the bringing in of these higher systems accompanying the act of attending" (p. 10). The general treatment of the topics of mind, consciousness, sensorimotor system, is so obviously literary, as opposed to scientific, that one wonders whether Ogden has recognized that modern psychology is seriously asking the question whether mind and consciousness are necessary or scientifically useful postulates in understanding human behavior and human achievement.

Seven relationships between mind and body are listed: Materialism and behaviorism; animism and interactionism; psychoneural parallelism; epiphenomenalism; the double aspect hypothesis; neutral monism; and the double language hypothesis which "regards neurology and psychology as being concerned with the very same facts, but concerned to describe them in two different languages" (pp. 21-26). Since the double language hypothesis is the one which the author adopts, we quote his understanding of it: "A child thinks that an orange looks yellow and has a size when there is no one there to see it." "But, the orange 'is a real thing which we only know in this physical or sensory way. Our own mind and its experiences we may know in this way as the brain and its processes, and in this way other people can know us equally well, or better than we know ourselves. But we also know our mind and its experience directly, and this no one can do but ourselves, who are our mind and have its experience.' Every remark in the one science can theoretically be translated into terms of the other" (p. 26).

A critical reader may wonder how a "double language" can solve the difficulties of materialism *versus* animism. Of course it does not, and as a result Ogden presents the traditional mixture: animism in the social aspects of psychology, materialism in the neural explana-

tions. This should leave everyone at ease, for "Those who resent a solution which would reduce all mental life to a mere play of brain processes, governed by laws into which such things as hopes, desires, purposes, and aspirations do not enter, can find on careful consideration no ground for objection"; "those feel a despair of a science whose methods and results do not admit of control and corroboration by the methods and results of the other sciences will" also "find their demand met" (p. 32). As a concession to "readability" even neural function is given in crudely animistic terms. In the chapter on impulse and inhibition, we find, *e.g.*, "The fact is that even the impulses which seem most insistent and independent have merely a precedence *allowed* by the others. They take their course by consent and in the general interest, and may, if the situation is sufficiently exceptional, be over-ruled" (p. 42). And again, "The highest centers are those which have to take note of the widest and most intricate situations and to order the largest and most varied sets of claims" (p. 42).

Four theories of inhibition are described: the neurin theory, drainage theory, refractory state, and chronaxies. The chapter on How the Brain Works is based mainly on Sherrington and Pavlov and is the best chapter in the book. Here Ogden sees rather clearly that "There is still much work to be done in the physiological laboratory whose results will undoubtedly have a direct bearing on these problems. The main attack has not yet been made. The work so far done amounts to 'getting the guns into position' for that attack" (p. 77). This seems to imply for Ogden that psychology is not yet ready to make fundamental assumptions. We know so very little of what we are trying to investigate that "to assume special 'psychical' agents, or to maintain that the working of the mind is beyond the scope of any possible physiological explanation would be a rash procedure for a psychologist to-day" (p. 77). It seems to the reviewer that this attitude accounts for much that is inconsistent in Professor Ogden's book. Would it not be more useful to accept either materialism or animism frankly and then try to follow out consistently whatever principle is adopted. What experimental program, for instance, can be derived from statements such as these: "The plan of the universe as we see it is the plan of the persistent accords in our nervous centers, the plan of the patterns by which we handle our stimulation" . . . "these patterns depend not only on what is given in stimulation to our sense organs, but still more upon the relative satisfaction to us as integral individuals of picking

out one pattern rather than another" (pp. 82-83). Is it not time that psychologists scrutinize their generalizations more closely? In this section we also find the topics: purpose and foresight, retention and attainment, recognition, interest and the selection of patterns, man's fundamental needs (food, sex, society), fixations, the nature of interest, initiation and action. Throughout these topics we find frequent references to physiology of the "readable" sort.

Chapter VI deals with the growth of mind in animals, VII with the mentality of apes, VIII with mental growth in man. The contents are based largely on Koffka and Koehler. The author has recognized the growing importance of what he calls man's linguistic heritage. With respect to the nature of speech, we learn that "all use of speech involves expression; but some vocal activity involves more than this, involves what is known technically as *objective reference*, and it is this further use of speech which is man's peculiar achievement" (p. 151).

A short chapter on behavior is mainly a criticism of behaviorism. Chapter XI, Looking Inwards, deals with ultimate modes of consciousness: cognition, affection, and conation. "Nearly every experience, it has generally been agreed, presents these distinct irreducible aspects. It is a knowing of, or a thinking about, something; it is pleasureable or unpleasant; and it is a striving toward something" (p. 187). Important topics are: striving and desire, the unity of mind, the process of introspection described in detail, pleasure-unpleasant, the limits of consciousness. The problem of thought presents itself to Ogden as follows: "The simplest form of thinking about things is perceiving them." . . . "The next most obvious form is imagining them." . . . "In both these forms of thinking" . . . "the thing is the principal cause, in a way which we can trace, of the mental event" (p. 226). "In addition to the thinking that is a recapitulation, as it were, of the concrete handling of things, there is another, a higher order of thinking, abstract or conceptual thinking" (p. 231).

In his sections on the emotions the author does not deviate widely from the older methods of presentation. "A surprising amount is known already about the phenomena of emotion and the difficulty is less due to a lack of data than to indecision as to what is to be called cause and what effect among these phenomena" (p. 238).

The chapter, How the Mind Goes Wrong, is a popular and sensible presentation of such topics as, the mutual obstruction of inter-

ests, various phases of psychoanalysis, conflict and repression, mechanisms of the unconscious, etc.

The final chapter, *Looking Forward*, deals with man's protracted infancy, school education, the transfer of training, vocational training, incentives, mental tests, etc. An idea of what to expect may be derived from a quotation from the concluding section, *The Need for Conscious Control*: "This need for increased conscious control of the machinery of life is even more evident when we turn to the influence which modern psychology is exerting in medicine. Why have we this sudden universal emphasis on the psychological origin of so much physical and mental disease? Is it not because the problems of existence which a little while ago were so simply solved, have with the increasing complexity of modern civilization, begun to put a strain upon the old mechanisms?" (p. 311).

The reason for the title of the book, "The Meaning of Psychology," has escaped the reviewer, and no mention is made of it in the text. There are many books on psychology now coming off the presses that still hold out for the untrained reader the illusion that psychology is still a "popular" science, to be acquired without special training. If Dr. Ogden's book is one of these, it is one of the best, whatever one may think of the principle itself.

ALBERT P. WEISS

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TROLAND, L. T. *The Mystery of the Mind*. New York: Van Noststrand, 1926.

In this book Dr. Troland presents scientific psychology for "the reader who has not made a special study of modern psychology" and for those of his colleagues who "do not seem to appreciate the mysteriousness of mind, because they have become so used to studying it" (p. vii). "The mystery of mind," he says, "also creates a *mystery of matter*," and when "we see how things stand between the facts of psychology and those of physics, we wonder which set of facts represents the more fundamental reality" (pp. 3, 4). After an analysis of what is included under such terms as I, we, you, etc., Troland concludes that "I am a mind" (p. 22), and that we should disregard all "interpretations of mind which identify it with bodily organs or processes" (p. 24). Underlying mind is the conscious and the subconscious. "Consciousness is a compound or mosaic of the various factors" (thoughts, things seen, heard, smelled, tasted, etc.). "Where these factors come from, and how they get com-

pound in the particular manner in which they are given, are interesting questions, but the answer does not affect the definition of consciousness, as such. Red apples and blue skies may come into consciousness from some place outside, but once they are inside of consciousness they are part and parcel of it. On the other hand, it is possible—and even likely, as we shall see—that all of these seemingly impersonal things of the external world are actually created within consciousness and have no existence apart from consciousness" (pp. 39, 40).

This statement is illustrated by a diagram (p. 40) showing the "relations of consciousness to its own contents and to other things." The author now enters a more detailed analysis of his dual system. For those psychologists who have been unable to keep up with the recent developments in theoretical physics, there follows an excellent description of electrons, protons, atoms, radio-activity, electromagnetic waves, chemical action, heat, solids, liquids, gases, electric currents, the principles of relativity, life and biology, etc.

The author concludes "that the world of modern physical science and the world in consciousness have *no common parts at all*" (p. 59). Dr. Troland does not seem to accept a psychophysical parallelism. He asserts: "Somewhere in the physical world, somewhere in the organism, somewhere in the nervous system, somewhere in the brain, there should be an integrated process which underlies consciousness in its entirety. This process, like consciousness, will be complex, although unified; and its various parts and aspects will be individually related to the parts and aspects of consciousness. We have decided, on the ground of known facts, that the physiological activity in question is to be found only in the association areas of the cerebral cortex" (p. 78).

Practically no attempt is made to get beyond the cortex. The whole efferent and motor mechanism is ignored and even in the afferent system Troland arbitrarily limits himself to a single neuron from each sensory (visual) element. With these limitations and in the face of the evidence which is piling up against cerebral localization of either structure or function one might expect Troland to find that, "The relation between the conscious object and the nerve current pattern in the cortex creates a profound mystery. There can be no doubt," he maintains, "that one determines the other but *how* we shall not attempt to say here. Later on we shall offer an astounding explanation" (p. 90). Troland then prepares the way for the "explanation" by a consideration of the physiological topics:

behavior as the expression of mind, how are bodily movements controlled, the nature of response, the cortex as a switchboard. These are followed by such psychological topics as: perception and behavior, imagination and association, attention and action, the nature of will, thought and action, "effort," etc.

In general the treatment is along traditional lines. As part of the explanation of Fig. 9 (p. 112), which diagrammatically shows the neural relationships between sense organs, cerebrum, spinal cord, muscles, we find the statement that, the "voluntary" nerve currents are *initiated* in the cerebral cortex. Troland himself seems to sense the contradictory character of some of these assertions. "These are paradoxes," he says, "which form portions of the mystery of the mind" (p. 113).

The next chapter (VIII) is introduced by the heading, "Why people behave as they do," and for those for whom this information is new, he develops rather clearly such topics as: the properties of nerve currents, synaptic resistance, the distribution of cortical resistances, non-cortical "reflexes," how is cortical resistance regulated? These sections lead to Troland's fundamental selective agents, namely, cortical encouragers and discouragers (p. 126). In conclusion, he says: "We can therefore classify all of the sense-organs and their accompanying nerves into three groups: those which discourage cortical connections, those which encourage such connections, and those which are neutral in the given respect" (p. 126). Upon this substructure are built such traditional topics as: feeling and learning, "Hedonism," Hedonism of the past, the measurement of feeling, the physiology of the higher feelings, the pleasure of novelty, the law of decay, emotions, human happiness and personality. They are presented in an uncritical animistic atmosphere, but followed by the caution, "Let us not forget, however, that these two systems" (consciousness and the material world) "are bound together by laws, so that the changes which occur in one seem to be determined by those which take place in the other" (p. 180). There follow well-written sections on the physical structure of nerve, polarization, depolarization, excitation and conduction, the mechanism of conduction, the basis of the excitation threshold, the all-or-none law, the physics of synaptic resistance.

In Chapter XIII, Troland presents his theory of the fundamental relations of consciousness and electricity. Some set of cortical elements "must operate somewhat on the principle of a radio set which is tuned to a particular wave-length. The radio receiver will pick up

the given wave-length regardless of the path by which it reaches the vicinity of the receiver. The only thing which counts is the inherent nature or quality of the specially selected wave" (p. 211). "There are nerve arrangements in the cortex which are tuned to 'red' regardless of accompanying features of the incoming nerve currents. There are other nerve formations which pick up the human figure regardless of size, position, or color; and so on." "Thus the 'red excitation' in the cortex, regarded as a whole, is a combination of structural and the dynamical (or change) features. *It is a certain structure undergoing a certain change*" (p. 212).

In more detail, he continues: "Any combination of electrical particles is held together by fields of electrical force. These fields lie between the particles and are essentially smooth or continuous in nature, although they have a characteristic form which is determined by the positions of the particles. It is equally true, however, to say that the positions of the particles are determined by the form of the field. The field may be regarded as a unitary thing whose form corresponds directly with the quality which appears in consciousness. There is nothing evident in consciousness which corresponds to the electrical particles, although the physicist tends to regard these as rather more important than the fields" (p. 214). It seems to the reviewer that modern physics is avoiding descriptions of the type that, the nature of the field is determined by the position of the particles or that the position of the particles is determined by the nature of the field. Physics no longer speaks of *determination*. The careful physicist merely asserts that certain constants of the field show a high correlation with certain geometrical distribution of the particles. As the reviewer has tried to picture this theory, we have (a) an electric field between the electrics, (b) a magnetic field whenever certain changes in the electric field take place. Now, is consciousness a third field (c) which adds an indeterminable variable to the electric and magnetic fields so that the relative positions of the electrics change and in this way modify consciousness or human behavior? Is the type of animism revealed in the following quotation to be regarded as a clearing or a clouding of the issue?

"As physical combinations become increasingly loose-jointed, a point is reached in the corresponding consciousness at which introspection is able to detect parts which correspond to separate constituents of the physical structure. These parts will be so-called elements of consciousness and will be clearly separable in proportion to the weakness of electric union of the corresponding physical fac-

tors" (p. 214). Or again: "If we believe that a pleasant feeling always accompanies congregation, then we must suppose that when an electron and a proton rush toward one another the corresponding sentient units are suffused with pleasure" (p. 240). It is, of course, easier to criticize than to do better, but this book was written for the avowed purpose of dealing with fundamental conceptions. The reader is justified in asking for a clear-cut formulation of these principles somewhere in the book. That the author himself has his doubts as to his own ability to formulate his postulates seems evident from his concluding remarks: "However, we cannot hope in the present book to make such a doctrine" (the relationship between consciousness and the physicist's theory) "really clear. To do so would be too difficult, and if successful would unduly dispel the 'mystery of mind,' which it has been our purpose to set forth rather than to solve" (p. 148). The book presents clearly, for those who are in need of such information, the facts of physics and biochemistry which are important for an understanding of human behavior. But, like so many other psychologists, Dr. Troland never really faces the question, Is the hypothesis of a mind or a consciousness a necessary or valuable assumption to account for the facts of human behavior and of human achievement?

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HENRI DELACROIX. *Psychologie de l'art: essai sur l'activité artistique*. Paris: Alcan, 1927. Pp. 481.

The resemblances between art and the activity of play have often been noted, and are numerous enough to give considerable support to the view that the creation and appreciation of art may be traced psychologically to the impulses which in the early stages of the individual and the race find their outlet in play. Play, through an excess of nervous energy (Spencer), seeks objects and themes necessary to its exercise but refuses to be put under constraint by any conventional limitations which its chosen materials generally impose. It lays hold on reality at the same time that it creates a make-believe world of its own. So far the analogy with art is apparent. Art makes use of objects and themes within the world of sense by which it may give expression to a life of dreams and imagination. It has its roots in reality while it strives to liberate the mind from the urgent demands of moral, social, and other practical values (Schiller). But striking as the similarities of the two activities undoubtedly are, their differ-

ences must not be overlooked. Many differences which have been cited turn out, upon examination, to be false. It is not correct, for example, to emphasize, in this regard, the serious character of art, for there are solemn games; nor its technique, for many games have theirs; nor its social action, for play is not foreign to society. There is one valid difference, however, of first rate importance. Play is almost completely indifferent to the intrinsic nature of its material. The player is concerned with his playthings only as means to arrive at certain ends, only as symbols of his intentions. They do not arrest his attention. They serve only as points of departure for the theme and action of his play. The artist, on the contrary, begins by loving his material for its own sake quite apart from its ultimate significance. The artist, whether creator or admirer, is possessed of a selective sensibility for this or that order of sensations or sensuous forms. It is as though he were predestined for one of the sensory spheres of existence. The work itself, the object of art, is part of the secret of esthetic power. The artist seeks to express within an harmonious and balanced order of sensory elements an aspect of human life.

The above summary of Delacroix's views on art and play may perhaps serve as an instance of the manner in which he tries to reach a *via media* among the opposing theories of art throughout the whole of the present volume. He gives full recognition to opposing claims in esthetic theory and generally includes both sides within some sort of synthesis or eclecticism, although at times he reveals an inclination to accept one specific line of argument without, however, denying the relevance of contrary positions to certain portions of the complex field of art. The first part of the book deals with the esthetic consciousness, the artist and his work, and the contemplation of ideas of art; the second part, with the elements which enter into some of the special fields of art.

In the second part of the book Delacroix devotes two long chapters to music. Poetry and painting are treated somewhat more briefly. In his analysis and descriptive account of music he again reveals his unwillingness to accept as final any one particular elaboration of the conflicting interpretations which derive from the two outstanding theories of musical meaning, viz., formalism and expressionism. The second chapter on music is entitled, significantly, "The Varieties of Musical Experience." In it he brings together an impressive amount of material on the different ways in which lovers of music, whether technically trained or not, describe their experience when listening to music. The ways of musical enjoyment include about all possible

varieties. To one person the beauty of music resides wholly within the stuff and form of auditory sensation itself; to another it comes from the understanding of cosmic harmony and eternal verities. Between these two extremes may be found a wealth of varieties of musical meanings. Who may say that one person's enjoyment of music is correct and another's incorrect?

It is only a partial truth to say that art is sensation, that it is form. It is both sensation and form. It is a copy of reality and an expression of the ideal. It is sensuous and also spiritual. It prolongs the realities of life and conduces to flights from life's realities. It is all of these, and more, by virtue of an unique synthetic and creative activity. In this way the author of the present volume tries to resolve numerous apparent conflicts in esthetic theory. It is a tendency congenial to many theorists of to-day in the field of art. Bullough with his *psychical distance* and Langfeld with his *esthetic attitude* are instances which come quickly to mind. The present work is a valuable contribution to the facts of esthetic experience. Its value for theory will be appraised variously. Its greatest defect consists of incomplete references in the form of footnotes and the absence of an index.

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CARL MURCHISON. *Criminal Intelligence*. Worcester: Clark Univ., 1926. Pp. 291.

This psychological study of intelligence is based on the army Alpha test which was given to the inmates of several reformatories and penitentiaries. A cross-comparison is made between the army Alpha norms and the Alpha scores of the incarcerated groups under consideration. In making these comparisons the writer says: "No assumption is made as to whether the Alpha test measures anything that is native. For the practical purposes of this book, intelligence is whatever is expressed quantitatively as measured by the Alpha test" (p. 8).

Dr. Murchison proceeds then to an elaborate tabular comparison, both absolute and percental, of army groups with his criminal groups. In order to get more homogeneous units the prisoners are divided into four classes: (1) white native-born men criminals, (2) white foreign-born men criminals, (3) negro men criminals, (4) women criminals. The main conclusions are:

1. The criminal groups are superior in Alpha intelligence to the

corresponding army groups, which Dr. Murchison estimates to be fairly representative of the civil population at large. But he does not feel that the incarcerated groups under consideration are representative, for he says: "The author was unable to find any wealthy man among the various inmates of the various prisons investigated. . . . The men who get convicted are usually without wealth and without friends. As a result it might be expected that the resulting mental norms would be too low to represent the important criminal element in society. . . . The criminals who have been suspected are probably much more intelligent than those who have been caught. . . . The men who are caught can scarcely be considered as possessing intelligence enough to furnish norms representative of the criminal element in society" (pp. 36-37, abbreviated).

It follows from these facts and considerations that the median intelligence for the caught criminal plus that for the uncaught criminal is considerably above the intelligence of the civil population.

2. If the incarcerated criminal is rather above the civilian population in intelligence, it follows that the guards should be men of superior intelligence in order to be able to deal with the criminals and institute any program of reform. Dr. Murchison waxes caustic when considering the actual situation: "The average score of the criminal was just 75 per cent higher than the average score of the guards. The only reason the guards continued to live was because the architects of the prison had done their job well" (p. 28). "The inmates of a certain prison in this country averaged nearly 100 per cent higher in the Alpha test than did the guards in the same prison. Which group was feeble-minded?" In comparable tests the reviewer has not found an equally marked difference between prisoners and guards.

3. "Men who are incarcerated outside their home state seem more intelligent than are the men incarcerated within their home state. The reviewer has found this probably true for the interstate criminal but not for the emigrant criminal from other states than Pennsylvania. The reason assigned by the author for this third conclusion is that "A moving population is probably more intelligent than a stationary one" (p. 57).

4. Recidivists are more intelligent than first offenders. The more intelligent recidivists repeat the same crime while the less intelligent ones "deviate into other crimes" (p. 96).

5. The criminal is much less literate than the American Army (p. 111).

6. There is no indication at all that intelligence is injured by length of incarceration (p. 151).

Dr. Murchison's results offer food for considerable thought. There may be an impressionistic view abroad that feeble-mindedness comes near to being the sole cause for crime; if it exists, that opinion needs confirmation. In the experience of the reviewer group tests did not give satisfactory results with large groups of prisoners. Dr. Murchison does not say whether or not he encountered difficulty in his use of group tests.

The last chapter is not an outgrowth of the foregoing Alpha data comparisons but seems to be an expression of the author's personal views on a miscellaneous group of penal topics. The radical penal changes which he recommends do not call for discussion in this journal.

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ALEXANDER ROUHIER. *Le Peyotl (Echinocactus Williamsii Lem.) La plante qui fait les yeux émerveillés.* Paris: Doin, 1927. Pp. xii+356.

This monograph is the most comprehensive single study on Peyotl<sup>1</sup> that has been published. M. Rouhier, a Lyonnais doctor of pharmacy, has brought together almost all of the previous scattered works and competently related the more or less confused data and the conclusions from his own original pharmaceutical, physiological, and psychological investigations. The result has been, as M. Perrot tells us in the preface, "a substantial and complete work"; and, "written in an original style with constant attention to scientific truth, it is full of interest to the reader who follows with curiosity the story of the 'divine plant' through the picturesque and variegated paths of its life, its legends, folk-lore, religious rites, its physiological properties and its social history." Indeed, M. Rouhier has included at least a short chapter on every possible phase of the subject; and with its almost complete bibliography, this monograph may well act as the basis for all future investigations on the same subject.

In the first part, "Geographical and Botanical Origin," the questions of terminology, etymology, and geographical distribution are

<sup>1</sup> "Peyote," "mescal buttons," "Anhalonium Lewinii," may be more familiar names of this little cactus plant that is used by certain Indian tribes of Mexico and of the United States in their religious ceremonies. M. Rouhier uses the name "Peyotl" because it is the oldest form and is to be preferred from the etymological point of view.

briefly discussed. A full detailed description of the morphology, internal and external, and of the histology of the plant is enriched by many diagrams and pictures. A complete taxonomy is given, and the opinions of many authors on the proper classification of the forms of this cactus are reviewed and criticised. A special classified bibliography of the botany of Peyotl is added here.

Part two, "History and Ethnology," contains descriptions of the many legends, magical ceremonies, and religious cults that have grown up around Peyotl in the Indian tribes of Mexico and our prairie states. Since ancient Aztec times this plant has generally been considered of supernatural origin. Each tribe has its own special legend and ceremonial practices, but all alike treat the little cactus as a means of communing with God. A detailed exposition of the Peyotl cult in the Huichols and the Tarahumares of Mexico follows in the main Carl Lumholtz's accounts. The "mescal ceremony" of the Kiowas of the United States is described after J. Mooney's account. A brief statement concerning the prohibitions against the use of Peyotl completes this section.

In part three, "Chemistry, Pharmacology, and Therapeutics," the several methods of chemical analysis that have been used are reviewed, and the chemical properties and reactions of the six Peyotl alkaloids are stated. The chapter, "Toxicity and Pharmaceutical-dynamics," includes mention of some of the previous observations of "mescal intoxication," a brief review of the psychophysiological effects of each alkaloid, and an account in full of four original observations: one, an experiment on the author himself; one, on a student of pharmacy at Lyons, and two on women—the first to be recorded in the literature. All these observations are purely qualitative and describe, chiefly, visual phenomena which are, on the whole, typical "mescal visions." In the following chapter, "L'ivresse peyotlique," M. Rouhier does some valuable work in classifying and generalizing the qualitative results of the psychological experiments; he correlates his observations with those of Havelock Ellis, Prentiss and Morgan, and Weir Mitchell, grouping the mescal visions into three types and developing a whole, unified picture of "mescal (peyotl) intoxication." The therapeutic uses of Peyotl among the Indians are very extensive, varying from its use as almost a panacea (to give health and long life, to purify the body and soul) among the Tarahumares to its use as a specific cure of headaches, consumption, and fevers of all kinds among the Kiowas. Among the white race, however, its medical use is practically null at the present time. The final chapter, "Posology,"

includes a list of four forms of Peyotl preparations, tinctures and pilules, with their respective alkaloid content and specific therapeutic doses.

M. Rouhier's conclusions may be briefly summarized as follows:

1. Peyotl has been and remains still, for certain Indian tribes of Mexico and the United States, the sacred plant *par excellence*.

2. Its area of vegetation is limited to some central and northern regions of Mexico and the extreme southwestern part of the United States.

3. The Indians use the entire aerial part of the cactus, which, cut in slices and dried, constitutes the "mescal buttons," the present commercial form of the drug in the United States.

4. Peyotl is polymorphous. Although its morphologic aspects may be enough different to account for the early assertion of the existence of two specific species, *Echinocactus Lewinii* Hen. and *E. Williamsii* Lem., an examination of the external and internal morphology of the plants leads to only one conclusion: there is but one unique species of Peyotl, *E. Williamsii* Lem., the various so-called subspecies being due to the polymorphic character of the plant. For example, *Anhalonium Lewinii* is the adult form. This conclusion is confirmed by the critical examination of the researches in the chemistry of Peyotl.

5. The six alkaloids that have been found in the various species vary only with the more or less accidental features of the nutrition of the plant, the weather, etc., and the time of gathering.

6. Peyotl, and only in very large doses, is but weakly poisonous. It does not seem toxic to man.

7. Its physiological action, a tonic-sedative and a stimulant of the nervous system, justifies its employment in medicine.

8. On the other hand, its unique action on the cerebrum renders it useful as a psychophysiological reagent with very different applications.

9. The use of Peyotl does not, properly speaking, produce euphoria, and is not habit-forming. It does not seem that its preparations could be ranked in the group of narcotics falling under the act of the Convention of Geneva, February, 1925.

10. At the present time it does not seem that one or the other of the separate alkaloids can replace a pan-peyotl preparation. Future work must establish by experimentation with the various alkaloids in isolation the special physiological and medical properties of each.

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## NOTES AND NEWS

THE 36th annual meeting of the American Psychological Association will be held at Ohio State University, Columbus, Ohio, on December 28, 29 and 30, 1927, under the presidency of Professor H. L. Hollingworth. Arrangements for accommodations should be made at once with Professor H. E. Burtt, Ohio State University. It is probable that reduced railroad fares will be available for everyone attending the meetings whether they are members of the Association or guests. In order to have the reduced railroad fares available it is necessary to have 250 of the railroad certificates validated. It is urged that those attending will purchase a one-way ticket to Columbus obtaining a certificate for the American Psychological Association (not a receipt). These when validated by Professor Burtt at the meetings will entitle the holder to return to the point of departure by the same route for a half fare.

DR. SIDNEY M. NEWHALL has been promoted to assistant professor of psychology at Yale University.

THE new sixteen-room psychological laboratory at Colgate University has been opened. The laboratory is divided into two parts, the first being a main laboratory of ten rooms for general, applied and industrial experiments, and a special sleep laboratory of six rooms located away from the noise of the campus.

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